MYCOTAXON

ISSN (print) 0093-4666 (online) 2154-8889 © 2016. Mycotaxon, Ltd.

July–September 2016—Volume 131, pp. 503–509

http://dx.doi.org/10.5248/131.503

New host records of rust fungi (*Pucciniales*) from Pakistan

B. Ali, Y. Sohail & A.S. Mumtaz*

Department of Plant Sciences, Faculty of Biological Sciences, Quaid-i-Azam University, Islamabad, 45320, Pakistan

*Correspondence to: *asmumtaz@qau.edu.pk*

Abstract—*Uredopeltis chevalieri* on *Grewia optiva* and on *G. tenax* are new host records; *Broussonetia papyrifera on Cerotelium fici* and *Phakopsora ziziphi-vulgaris* on *Ziziphus spina-christi* are new host records for Pakistan; and within Pakistan *P. ziziphi-vulgaris* on *Ziziphus oxyphylla* is a new host record for the Islamabad region. An additional collection of *Phragmidium rosae-moschatae* on *Rosa centifolia* from Pakistan is described and illustrated.

Key words—Hazara Division, Margalla hills, Murree, *Uredinales*

Introduction

Pakistan is gifted with a rich and diverse flora with approximately 6000 species of wild plants, based on which the country has been divided into four phytogeographical regions: Irano-Turanian (46%), Sino-Himalayan (10%), Saharo-Sindian (9.5%), and Indian element (4.5%) (Hamayun 2003). About 400 species of rust fungi on 350 different host plant species have been reported in Pakistan (Ahmad et al. 1997). *Grewia tenax*, *Broussonetia papyrifera* and *Rosa centifolia* are exotic plants in Pakistan, while *Grewia optiva*, *Ziziphus spina-christi*, and *Z. oxyphylla* are native plants.

Both rust fungi and their host plants are still under-explored in Pakistan. In 2014 and 2015, fieldwork was carried out in different regions of the country to collect and investigate rust fungi and their hosts. Here we provide descriptions and illustrations including scanning electron micrographs of four new records of rust fungi.

Materials & methods

Different regions of Pakistan were surveyed for rust fungi in 2014–15. Collections of the infected plant material were preserved in the herbarium of Plant Sciences

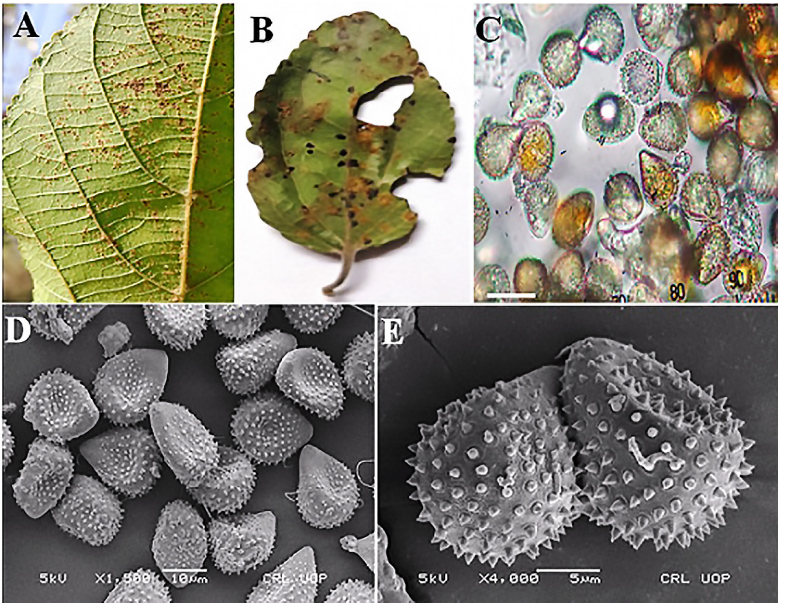
Department, Quaid-i-Azam University, Islamabad, Pakistan (ISL), and rust spores were mounted in glycerin jelly and fixed as semi-permanent slides. The spores were measured and photographed at 100× and 1000× magnifications under a Leitz HM-LU compound light microscope. At least 30 spores were measured for each spore stage, including the smallest and the largest spores found. Host plants were identified by comparing new collections with botanical specimens held in herb. ISL. Rust fungi were identified using the descriptions of McKenzie (1986), Walker & Shivas (2004), Sultan (2005), Berndt & Wood (2012), Afshan et al. (2012), Fiaz et al. (2015), and Yun (2016). For scanning electron microscopy the spores were scraped from the leaves, mounted on a stub, coated with gold in a sputter-coater, and examined with a JSM-5910 SEM.

New records

Uredopeltis chevalieri J. Walker & R.G. Shivas, Australas. Plant Path. 33: 43 (2004) PLATE 1

= *Phakopsora grewiae* (Pat. & Har.) Cummins, Bull. Torrey Bot. Club 72: 206 (1945)

SPERMOGONIA, AECIA, and TELIA not observed. UREDINIA mostly hypophyllous, scattered, about 1 mm in diam., reddish brown, subepidermal, paraphyses clavate, fused below and free above, incurved to irregular, hyaline to faintly yellowish, narrower at base. UREDINIOSPORES globose, subglobose to



Uredopeltis chevalieri. A. Abaxial leaf surface of *Grewia optiva* with brown uredinia. B. Adaxial leaf surface of *G. tenax* with brown uredinia and telia. C. Urediniospores on *G. tenax.* D, E. Scanning electron micrographs showing echinulate urediniospores with smooth bases. Scale bar: C = 10 µm.

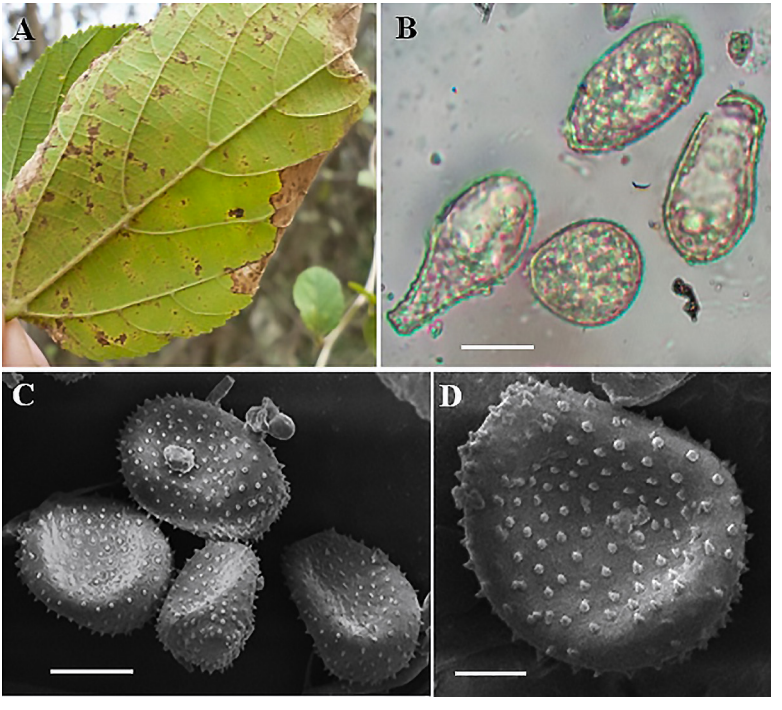
oval or pyriform, sometimes irregular, pale yellow to pale yellowish-brown or rarely hyaline, (18–)20–28(–31) × (15–)17–20(–22) µm in size, wall uniformly 1(–2) µm thick, echinulate, spores mostly with smooth bases, 4 equatorial germ pores.

Material examined—**PAKISTAN, Punjab**, Islamabad, Pir Sohawa, 823 m a.s.l., on *Grewia tenax* (Forssk.) Fiori, (*Malvaceae*), stage II, December 2014, B. Ali # BA60 (ISL-53522); on *G. optiva* J.R. Drumm. ex Burret, stage II, December 2014, B. Ali BA61 (ISL-29434); Islamabad, QAU, 595 m a.s.1., on *G. optiva*, stage II, December 2014, B. Ali BA22 (ISL-29435).

Comments—*Uredopeltis chevalieri* has been previously reported from Pakistan (as *Phakopsora grewiae*) on *Grewia asiatica* (Rahber-Bhatti et al. 1988, Ahmad et al. 1997). *Grewia optiva* and *G. tenax* are new host records for *U. chevalieri* worldwide.

Cerotelium fici (Castagne) Arthur, Bull. Torrey Bot. Club 44: 509 (1917) Plate 2

Spermogonia, aecia, and telia not observed. Uredinia hypophyllous, brown or pale brown, small, pulverulent, scattered, in groups, covered by



Cerotelium fici. A. Abaxial leaf surface of *Broussonetia papyrifera* with uredinia. B. Urediniospores C, D. SEM micrographs of finely echinulate urediniospores. Scale bars: B = 8 µm, C = 10 µm, D = 5 µm.

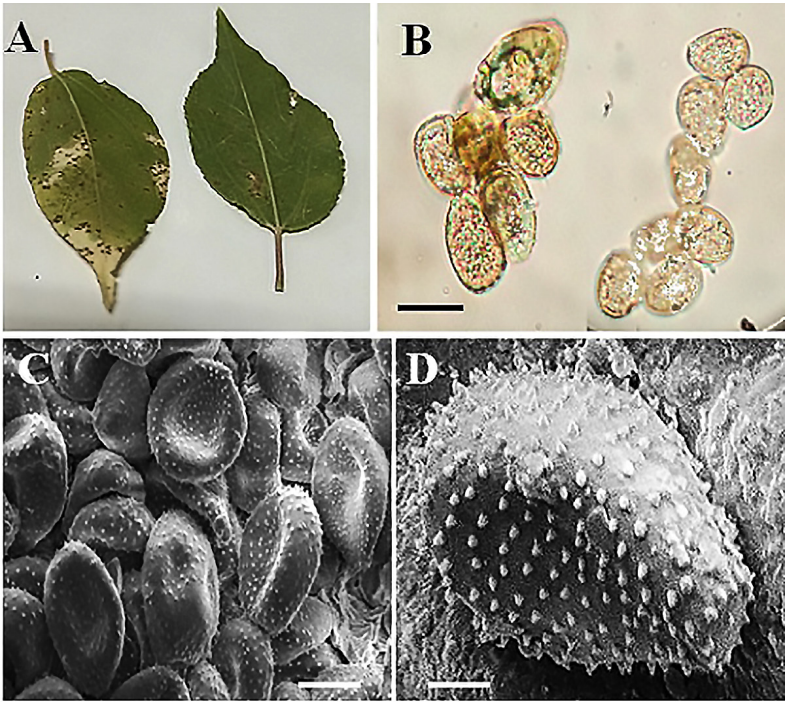
epidermis, surrounded by paraphyses. Urediniospores hyaline, ellipsoid, ovoid, elongated, subglobose, 26–36 × 14–22 µm in size, wall 1.5–2.5 µm thick, echinulate.

Material examined — **PAKISTAN, Khyber Pakhtunkhwa**, Hazara region, Haripur District, 538 m a.s.l., on *Broussonetia papyrifera* (L.) L'Hér. ex Vent. (*Moraceae*), stage II, December 2014, B. Ali # BA73 (ISL-114420).

Comments — *Cerotelium fici* has been previously described in Pakistan on *Ficus palmata*, *F. carica*, and *F. religiosa* (Ahmad 1956, Kaneko 1993, Iqbal & Khalid 1996, Ahmad et al. 1997, Fiaz et al. 2015). *Broussonetia papyrifera* is here recorded for the first time as a host of *C. fici* in Pakistan.

Phakopsora ziziphi-vulgaris Dietel, Ann. Mycol. 8: 469 (1910) Plate 3

Spermogonia, aecia, and telia not observed. Uredinia hypophyllous, in irregular groups, pale brown, pulverulent. Urediniospores globose to oval or

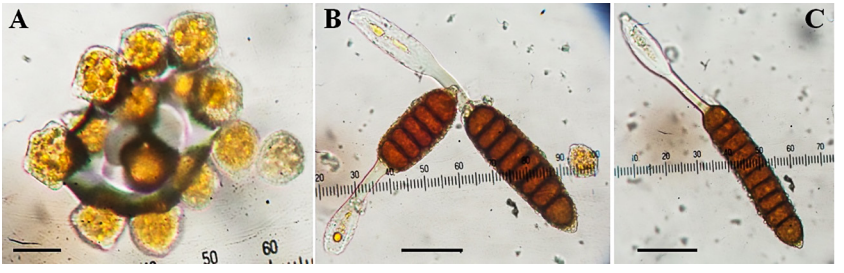


Phakopsora ziziphi-vulgaris A. Infected leaves of *Ziziphus oxyphylla*. B. Urediniospores on *Z. spina-christi*. C, D. SEM micrographs of echinulate urediniospores on *Z. spina-christi*. Scale bars: B = 10 µm, C, D = 15 µm.

obovoid, sometimes slightly irregular, pale brown to orange brown, 17.5–27.5 × 10–17.5 µm in size, wall 1.5–2.5 µm thick, echinulate, smooth areas in middle section of some spores.

Material examined — **Pakistan, Punjab Province,** Islamabad, Pir Sahwa, 823 m a.s.l., on *Ziziphus oxyphylla* Edgew. (*Rhamnaceae*), stage II, December 2014, B. Ali # BA49 (ISL-66410); Islamabad, QAU, 610 m a.s.l., on *Z. spina-christi* (L.) Desf., stage II, November-December 2014, B. Ali # BAH (ISL-66411).

Comments — *Phakopsora ziziphi-vulgaris* has been previously reported on *Ziziphus jujuba* from different regions of Pakistan (Ahmad 1956, Hasnain et al. 1959, Iqbal & Khalid 1996, Ahmad et al. 1997) and on *Z. oxyphylla* from Chakwal and Kallar Kahar (Kaneko 1993, Ahmad et al. 1997). Berndt & Wood (2012) recorded *Z. spina-christi* as a host of *P. ziziphi-vulgaris* in Israel. Here, *Z. spina-christi* is newly recorded from Pakistan as a host of *P. ziziphi-vulgaris*, and *Z. oxyphylla* represents a new host from the Islamabad region, Punjab.



Phragmidium rosae-moschatae. A. Urediniospores with yellowish contents. B. Teliospores with 5 and 8 cells. C. Teliospore with 10 cells. Scale bars: A = 10 µm, B, C = 50 µm.

Phragmidium rosae-moschatae Dietel, Hedwigia 44: 132 (1905) Plate 4

Spermogonia and aecia not observed. Uredinia hypophyllous, cinnamon brown, minute, rounded, scattered. Urediniospores 22–28 × 18–22 µm, globose to subglobose, single-celled, wall hyaline to yellow brown, 2–3 µm thick, coarsely verrucose, germ pores indistinct. Telia hypophyllous, black, minute, scattered. Teliospores 70–130 × 24–35 µm, cylindrical, rounded at both ends, deep brown to light brown, (5–)7–8(–10)-celled, wall dark brown to chestnut brown, 2–4 µm thick, with 2 germ pores, verrucose, with an apical papilla 7–13 µm in length, hyaline. Pedicel hyaline to olivaceous brown, 85–115 µm, at apex 8–10 µm thick, thickened to 14–25 µm at base, persistent, often with yellowish contents at base.

Material examined — **PAKISTAN, Khyber Pakhtunkhwa,** Muree, Ghora Gali, 1767 m a.s.l., on *Rosa centifolia* L. (*Rosaceae*), stages II+III, December 2014, B. Ali # BA22 (ISL-122345).

Comments — *Phragmidium rosae-moschatae* has been previously reported in Pakistan on *Rosa brunonii* [= *R. moschata*], *R. lacerans*, *R. webbiana*, and *R. centifolia* from Quetta, Murree, Peshawar, Tarnab, Swat, Kaghan Valley, and Tatu-Fairy Meadows in Pakistan (Malik & Khan 1944, Ahmad 1956, Jørstad & Iqbal 1967, Malik et al. 1968, Ono & Kakishima 1992, Ono 1992, Kakishima et al. 1993, Sultan 2005, Afshan et al. 2012). The number of cells in teliospores is variable: in the species protologue, Dietel (1905) described 5–10-celled teliospores; Pakistani teliospores have been described as (4–)7–8-celled by Jørstad & Iqbal (1967), as 5–7(–8)-celled by Sultan (2005) and Afshan et al. (2012), and as (5–)7–8(–10)-celled in this paper; and in a general modern description, Yun (2016) cited 5–7(–11)-celled teliospores.

Acknowledgements

We are sincerely thankful to Dr. Amy Rossman (Department of Botany and Plant Pathology, Oregon State University) and Dr. Merje Toome (Plant Health and Environment Laboratory, Ministry for Primary Industries, Auckland, New Zealand) for acting as presubmission reviewers and Dr. Shaun Pennycook (Auckland, New Zealand) for nomenclatural review and suggestions.

Literature cited

Afshan NS, Khalid AN, Niazi AR. 2012. Some new rust fungi (*Uredinales*) from Fairy Meadows Northern Areas, Pakistan. Journal of Yeast and Fungal Research 3: 65–73.

Ahmad S. 1956. Fungi of Pakistan. Biological Society of Pakistan, Lahore Monograph 1. 126 p.

Ahmad S, Iqbal SH, Khalid AN. 1997. Fungi of Pakistan. Sultan Ahmad Mycological Society of Pakistan, Dept. Bot. Univ. Punjab, Lahore, Pakistan. 248 p.

Berndt R, Wood AR. 2012. Additions to the rust fungi of South Africa. Mycological Progress 11: 483–497. http://dx.doi.org/10.1007/s11557-011-0764-z

Dietel P. 1905. Über die Arten der Gattung *Phragmidium*. Hedwigia 44: 112–132.

Fiaz M, Ahmad H, Afshan NS, Khalid AN. 2015. Some new records of *Uredinales* from Khyber Pakhtunkhwa, Pakistan. Mycotaxon 130: 569–575. http://dx.doi.org/10.5248/130.569

Hamayun M. 2003. Ethnobotanical studies of some useful shrubs and trees of District Buner, NWFP, Pakistan. Journal of Ethnobotanical Leaflets, Southern Illinois University, Carbondale IL, USA. 17 p. opensiuc.lib.siu.edu/cgi/viewcontent.cgi?article=1563&context=ebl

Hasnain SZ, Khan A, Zaidi AJ. 1959. Rusts and smuts of Karachi. Dept. Bot., Univ. Karachi, Monograph 2. 33 p.

Iqbal SH, Khalid AN. 1996. Material for the fungus flora of Pakistan. II. An updated check list of rust fungi (*Uredinales*) of Pakistan. Sultania 1: 39–67.

Jørstad I, Iqbal SH. 1967. Uredinales from West Pakistan. Nytt Magasin for Botanikk 14: 31–38.

Kakishima M, Izumi O, Ono Y. 1993. Rust fungi (*Uredinales*) of Pakistan collected in 1991. Cryptogamic Flora of Pakistan 2: 169–179.

Kaneko S. 1993. Parasitic Fungi on Woody Plants from Pakistan Himalaya. Cryptogamic Flora of Pakistan 2: 149–168.

Malik SA, Javaid MT, Ahmad M. 1968. *Uredinales* of Quetta-Kalat region of Pakistan. Biologia 14: 37–46.

Malik SA, Khan MA. 1944. Parasitic fungi of the North-West Frontier Province. Indian Journal of Agricultural Sciences 13: 522–527.

McKenzie EHC, 1986. New plant disease record in New Zealand: Fig rust (*Cerotelium fici*) on *Ficus carica*. New Zealand Journal of Agricultural Research 29: 707–710. http://dx.10.1080/00288233.1986.10430467

Ono Y, Kakishima M. 1992. *Uredinales* collected in the Swat Valley, Pakistan. Cryptogamic Flora of Pakistan 1: 197–216.

Ono Y. 1992. *Uredinales* collected in the Kaghan Valley, Pakistan. Cryptogamic Flora of Pakistan 1: 217–240.

Rahber-Bhatti MH, Memon MI, Shahani NM, Khuhro MA. 1988. Laboratory evaluation of some plants against rust. Pakistan Journal of Agricultural Research 9: 274–277.

Sultan MA. 2005. Taxonomic study of rust flora of Northern Areas of Pakistan. Ph.D. Thesis, University of the Punjab. Lahore, Pakistan.

Walker J, Shivas RG. 2004. *Uredopeltis chevalieri* sp. nov., the rust of *Grewia* (*Tiliaceae*) formerly known as *Phakopsora* (or *Dasturella*) *grewiae*, its first record in Australia and a summary of the known rusts of *Grewia*. Australasian Plant Pathology 33: 41–47.

Yun HY. 2016. Musk rose rust – *Phragmidium rosae-moschatae*. Systematic Mycology and Microbiology, ARS, USDA – Invasive and Emerging Fungal Pathogens – Diagnostic Fact Sheets. http://nt.ars-grin.gov/sbmlweb/fungi/diagnosticfactsheets.cfm [Retrieved 30 January 2016].